

What is claimed is:

1. A transcoding method of performing conversion between compressed bitstreams having at least syntax elements and video elements corresponding to video data, the transcoding method comprising the steps of:

a) decoding a first bitstream compressed according to a first compression method and parsing syntax elements and video elements;

b) mapping the parsed syntax elements to syntax elements complying with a target second compression method;

c) partially reconstructing video data complying with the first compression method from the parsed video elements;

d) requantizing the video data reconstructed in the step c) according to the second compression method; and

e) coding the mapped syntax elements and the requantized video data to obtain a bitstream complying with the second compression method.

2. The transcoding method of claim 1, wherein the first compression method is a moving picture experts group (MPEG)-1 compression method, the second compression method is a MPEG-4 compression method, and the step b) comprises:

b-1) converting a MPEG-1 f\_code into a MPEG-4 f\_code;

b-2) converting a MPEG-1 macroblock (MB) type into a MPEG-4 MB type;

b-3) converting a MPEG-1 coded block pattern (CBP) into a MPEG-4 CBP;

and

b-4) converting a MPEG-1 MQQUANT value (a quantization parameter in MPEG-1) into a MPEG-4 DQUANT value (a difference of quantization parameters).

3. The transcoding method of claim 2, wherein the step b-1) performs the conversion according to the following equation,

$$\begin{aligned} \text{vop\_f\_code\_forward} \\ = \max((\text{forward\_f\_code} - 1), 1) \end{aligned}$$

where max(a, b) is an operator of selecting a larger value between "a" and "b".

4. The transcoding method of claim 2, wherein the step b-2) comprises the steps of:

(i) setting "nomc+coded" as a MPEG-4 "inter" type and setting a motion vector to (0, 0);

(ii) setting "nomc+coded+q" as a MPEG-4 "inter+q" type and setting a motion vector to (0, 0);

(iii) setting "mc+not coded" as a MPEG-4 "inter" type, using a motion vector as it is, and setting both "cbpy" and "cbpc" to zero; and

(iv) setting the value of "code" determining "not coded" in MPEG-4 to 0 such as "cod=0" as many times as skipped MBs.

5. The transcoding method of claim 2, wherein the step b-3) comprises the steps of:

b-3-1) individually coding cbpy according to the following equation,

$$cbpy = (cbp \& 0x3c) \gg 2$$

where "&" indicates an AND operation performed in bit unit, "0x3c" indicates "3c" of a hexadecimal number, and ">>n" indicates an n-bit right shift operation; and

b-3-2) coding cbpc according to the following equation,

$$cbpc = (cbp \& 0x03) \gg 2,$$

and

the cbpc is united with the MB type obtained in the above step b-2) and coded to comply with an mcbpc VLC table of corresponding MPEG-4 I-VOP and P-VOP.

6. The transcoding method of claim 2, wherein the step b-4) performs the conversion according to the following equation,

dquant

$$= \min (\max ((mquant \text{ of current MB} - mquant \text{ of previous MB}), -2), 2).$$

1           7.       The transcoding method of claim 2, wherein the step d) comprises the  
2 steps of:

3           estimating a Laplacian distribution of a discrete cosine transform (DCT)  
4 coefficient reconstructed from a MPEG-1 bit stream;  
5           determining a reconstruction level using the estimated Laplacian distribution  
6 of the DCT coefficient; and  
7           performing quantization according to MPEG-4 using the determined  
8 reconstruction level.

1           8.       The transcoding method of claim 2, wherein when an output  $y$  with  
respect to an input DCT coefficient  $x$  is expressed by  $y = Q_1(x) = \left\lfloor \left\lfloor \frac{x}{\Delta} + \frac{1}{2} \right\rfloor \cdot \Delta \right\rfloor$ , a

quantization step size  $\Delta_i$  is given by  $\Delta_i = \frac{Wi \cdot Q_p}{8}$ ,  $i = 0, 1, 2, \dots, 63$  ( $Q_p$  is a

quantization parameter), a decision level  $t_m$  is given by  $t_m = (m - \frac{1}{2}) \cdot \Delta$ ,  $m \geq 1$ ,

$x_m = \{x | x \in [t_m, t_{m+1}]\}$  when  $x$  belongs to a section  $[t_m, t_{m+1}]$ , an amplitude level  $\lambda_m$  of  $x_m$

6 is expressed by  $\lambda_m = \left\lfloor \frac{x_m}{\Delta} + \frac{1}{2} \right\rfloor$ , an output  $x'$  with respect to the input DCT

7 coefficient  $y$ , which has been quantized by a MPEG-1 quantizer having a dead zone  
8 in which a reconstruction level for  $x_m$ , that is, an inverse-quantized DCT coefficient  $r_m$   
9 is given by  $r_m = \lfloor \lambda_m \cdot \Delta \rfloor$ , is expressed by

$$x' = Q_2(y) = \begin{cases} \left\lfloor \left\lfloor \frac{y}{\Delta'} \right\rfloor \cdot \Delta' + \frac{\Delta'}{2} \right\rfloor & \text{if } Q_p \text{ is odd} \\ \left\lfloor \left\lfloor \frac{y}{\Delta'} \right\rfloor \cdot \Delta' + \frac{\Delta'}{2} \right\rfloor - 1 & \text{if } Q_p \text{ is even} \end{cases}, \text{ a quantization step size } \Delta' \text{ is}$$

given by  $\Delta' = 2Q_p$ , a decision level  $t'_n$  is given by  $t'_n = n \cdot \Delta'$ ,  $n \geq 1$ ,

$y_n = \{y | y \in [t'_n, t'_{n+1}]\}$  when the output  $y$  belongs to a section  $[t'_n, t'_{n+1}]$ , and an amplitude level of  $y_n$ , that is, an inverse-quantized DCT coefficient  $\lambda'_n$  is requantized by a MPEG-4 quantizer having a dead zone defined as  $\lambda'_n = \left\lfloor \frac{y_n}{\Delta'} \right\rfloor$  and is

converted into a MPEG-4 DCT coefficient, the step d) comprises the steps of:

d-1) defining subscript values allowing the decision level to belong to a section  $[t_m, t_{m+1}]$  as a set  $P = \{p | t'_p \in [t_m, t_{m+1}]\}$ ;

d-2) defining candidates of the subscript values of the decision level as a set  $K = P \cup \{\min\{P\} - 1\}$  where the symbol  $\cup$  indicates a union and an operator  $\min\{A\}$  indicates a minimum value among the members of a set  $A$ ; and

d-3) selecting a member satisfying a cost function from among the candidate subscript values as a final subscript value, the cost function being expressed by

$$k = \arg \min_{k \in K} |C_m - r'_k| \quad \text{where} \quad C_m = \frac{\int_{t_m}^{t_{m+1}} x \cdot p(x) dx}{\int_{t_m}^{t_{m+1}} p(x) dx}$$

where  $C_m$  is an optimum reconstruction level in the section  $[t_m, t_{m+1}]$  used by a Lloyd-Max quantizer in view of mean square error, and  $p(x)$  is a Laplacian distribution function.

9. The transcoding method of claim 8, wherein in the step d-3),  $C_m$  is obtained by analyzing the statistical characteristic of  $p(x)$ .

10. The transcoding method of claim 9, wherein when it is assumed that AC DCT coefficients comply with a Laplacian distribution expressed by

$$p(x) = \frac{\lambda}{2} \cdot e^{-\lambda|x|},$$

a step of determining the value of  $\lambda$  determining the statistical characteristic of  $p(x)$  comprises the steps of:

d-3-1) calculating an average of a random variable  $|x|$  according to

$$E(|x|) = \int_{-\infty}^{\infty} |x| \cdot p(x) dx = \int_{-\infty}^{\infty} |x| \cdot \frac{\lambda}{2} \cdot e^{-\lambda|x|} dx = \frac{1}{\lambda}; \text{ and}$$

d-3-2) determining  $\lambda$  according to  $\lambda = \frac{1}{E(|x|)}$ .

11. The transcoding method of claim 10, wherein the step d-3-2) comprises the steps of:

d-3-2-1) approximating the value of  $E(|x|)$  according to

$$E(|x|) \cong E(|y|) + E(|z|)_{\frac{\Delta}{2}}$$

where  $E(|z|)_{\frac{\Delta}{2}} = \int_{-\frac{\Delta}{2}}^{\frac{\Delta}{2}} |z| \cdot p(z) dz$ , and  $p(z) = \frac{\lambda'}{2} \cdot e^{-\lambda'|z|}$  where  $\lambda' = \frac{1}{E(|y|)}$ ;

d-3-2-2) calculating  $E(|z|)_{\frac{\Delta}{2}}$  according to

$$E(|z|)_{\frac{\Delta}{2}} = 2 \cdot \int_0^{\frac{\Delta}{2}} z \cdot \frac{\lambda'}{2} \cdot e^{-\lambda'z} dz = \frac{1}{\lambda'} - e^{-\lambda'\Delta/2} \left( \frac{1}{\lambda'} + \frac{\Delta}{2} \right); \text{ and}$$

d-3-2-3) estimating the value of  $\lambda$  according to

$$\lambda = \frac{1}{E(|x|)} \cong \frac{1}{E(|y|) + E(|z|)_{\frac{\Delta}{2}}} = \frac{\lambda'}{2 - e^{-\lambda'\Delta/2} (1 + \frac{\Delta}{2} \lambda')}.$$

12. A requantizing method in which an output  $y$  with respect to an input DCT coefficient  $x$  is expressed by  $y = Q_1(x) = \left\lfloor \left\lfloor \frac{x}{\Delta} + \frac{1}{2} \right\rfloor \cdot \Delta \right\rfloor$ , a quantization step size

$\Delta_i$  is given by  $\Delta_i = \frac{Wi \cdot Q_p}{8}$ ,  $i = 0, 1, 2, \dots, 63$  ( $Q_p$  is a quantization parameter), a

decision level  $t_m$  is given by  $t_m = (m - \frac{1}{2}) \cdot \Delta$ ,  $m \geq 1$ ,  $x_m = \{x | x \in [t_m, t_{m+1}]\}$  when  $x$

belongs to a section  $[t_m, t_{m+1}]$ , an amplitude level  $\lambda_m$  of  $x_m$  is expressed by

$\lambda_m = \left\lfloor \frac{x_m}{\Delta} + \frac{1}{2} \right\rfloor$ , an output  $x'$  with respect to the input DCT coefficient  $y$ , which has

been quantized by a MPEG-1 quantizer having a dead zone in which a reconstruction level for  $x_m$ , that is, an inverse-quantized DCT coefficient  $r_m$  is given by  $r_m = \lfloor \lambda_m \cdot \Delta \rfloor$ , is expressed by

$$x' = Q_2(y) = \begin{cases} \left\lfloor \left\lfloor \frac{y}{\Delta'} \right\rfloor \cdot \Delta' + \frac{\Delta'}{2} \right\rfloor & \text{if } Q_p \text{ is odd} \\ \left\lfloor \left\lfloor \frac{y}{\Delta'} \right\rfloor \cdot \Delta' + \frac{\Delta'}{2} \right\rfloor - 1 & \text{if } Q_p \text{ is even} \end{cases}, \text{ a quantization step size } \Delta' \text{ is}$$

given by  $\Delta' = 2Q_p$ , a decision level  $t'_n$  is given by  $t'_n = n \cdot \Delta'$ ,  $n \geq 1$ ,

$y_n = \{y | y \in [t'_n, t'_{n+1}]\}$  when the output  $y$  belongs to a section  $[t'_n, t'_{n+1}]$ , and an

amplitude level of  $y_n$ , that is, an inverse-quantized DCT coefficient  $\lambda'_n$  is requantized

by a MPEG-4 quantizer having a dead zone defined as  $\lambda'_n = \left\lfloor \frac{y_n}{\Delta'} \right\rfloor$  and is

converted into a MPEG-4 DCT coefficient, the requantizing method comprising the steps of:

d-1) defining subscript values allowing the decision level to belong to a section  $[t_m, t_{m+1}]$  as a set  $P = \{p | t'_p \in [t_m, t_{m+1}]\}$ ;

d-2) defining candidates of the subscript values of the decision level as a set  $K = P \cup \{\min\{P\} - 1\}$  where the symbol  $\cup$  indicates a union and an operator  $\min\{A\}$  indicates a minimum value among the members of a set  $A$ ; and

d-3) selecting a member satisfying a cost function from among the candidate subscript values as a final subscript value, the cost function being expressed by

$$k = \arg \min_{k \in K} |C_m - r'_k| \quad \text{where} \quad C_m = \frac{\int_{t_m}^{t_{m+1}} x \cdot p(x) dx}{\int_{t_m}^{t_{m+1}} p(x) dx}$$

where  $C_m$  is an optimum reconstruction level in the section  $[t_m, t_{m+1}]$  used by a Lloyd-Max quantizer in view of mean square error, and  $p(x)$  is a Laplacian distribution function.

13. The requantizing method of claim 12, wherein in the step d-3), the balance point  $C_m$  is obtained by analyzing the statistical characteristic of  $p(x)$ .

14. The requantizing method of claim 13, wherein when it is assumed that AC DCT coefficients comply with a Laplacian distribution expressed by

$$p(x) = \frac{\lambda}{2} \cdot e^{-\lambda|x|},$$

a step of determining the value of  $\lambda$  determining the statistical characteristic of  $p(x)$  comprises the steps of:

d-3-1) calculating an average of a random variable  $|x|$  according to

$$E(|x|) = \int_{-\infty}^{\infty} |x| \cdot p(x) dx = \int_{-\infty}^{\infty} |x| \cdot \frac{\lambda}{2} \cdot e^{-\lambda|x|} dx = \frac{1}{\lambda}; \text{ and}$$

d-3-2) determining  $\lambda$  according to  $\lambda = \frac{1}{E(|x|)}$ .

15. The transcoding method of claim 14, wherein the step d-3-2) comprises the steps of:

d-3-2-1) approximating the value of  $E(|x|)$  according to

$$E(|x|) \cong E(|y|) + E(|z|)_{\frac{\Delta}{2}}$$

where  $E(|z|)_{\frac{\Delta}{2}} = \int_{-\frac{\Delta}{2}}^{\frac{\Delta}{2}} |z| \cdot p(z) dz$ , and  $p(z) = \frac{\lambda'}{2} \cdot e^{-\lambda'|z|}$  where  $\lambda' = \frac{1}{E(|y|)}$ ;

d-3-2-2) calculating  $E(|z|)_{\frac{\Delta}{2}}$  according to

$$E(|z|)_{\frac{\Delta}{2}} = 2 \cdot \int_0^{\frac{\Delta}{2}} z \cdot \frac{\lambda'}{2} \cdot e^{-\lambda'z} dz = \frac{1}{\lambda'} - e^{-\lambda'\Delta/2} \left( \frac{1}{\lambda'} + \frac{\Delta}{2} \right); \text{ and}$$

d-3-2-3) estimating the value of  $\lambda$  according to

$$\lambda = \frac{1}{E(|x|)} \cong \frac{1}{E(|y|) + E(|z|)_{\frac{\Delta}{2}}} = \frac{\lambda'}{2 - e^{-\lambda'\Delta/2} \left( 1 + \frac{\Delta}{2} \lambda' \right)}.$$

16. A transcoding apparatus of performing conversion between compressed bitstreams having at least syntax elements and video elements corresponding to video data, the transcoding apparatus comprising:

a decoder for reconstructing syntax elements and video elements from a first bitstream complying with a first compression method;

an inverse quantizer for inverse-quantizing the video elements provided from the decoder according to the first compression method to reconstruct video data;

a quantizer for requantizing the video data according to a second compression method;

a syntax generator for mapping the syntax elements provided from the decoder to syntax elements complying with the second compression method; and

an encoder for encoding the requantized video data (video elements complying with the second compression method) provided from the quantizer and

